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A. R. Luria, in his conception of the verbal control of behavior, regards four fundamental and distinctive functional attributes of the human speech system as making up a signaling system that humans alone possess: (1) the nominative role of language, (2) the generalizing or semantic role, (3) the communicative role, and (4) the role of regulating, directing, or controlling sequential behavior. Prior to the time a child learns to speak, his signaling system is nonverbal and is generated by the physical attributes of the surrounding environment. Luria contends that as the individual matures, the two signaling systems, verbal and nonverbal, work more closely together. He states that the verbal system, both in its communicative and regulative aspects, makes possible novel and flexible behavior without the tedious conditioning necessary for animal learning. Luria views speech as being formed through a series of transformations (substages) rather than through quantitative increases in such things as vocabulary and grammatical rules. In order to test Luria's theory, an experiment involving discrimination was administered to 32 children between the ages of 41 and 78 months. The results generally supported the hypotheses. (WD)

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Luria's Model of the Verbal Control of Behavior

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Luria's Model of the Verbal Control of Behavior[1]

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'Verbal control of behavior' is used to express a concern with the effect of verbal commands or instructions (of external or internal origin) on behavior. While many studies of verbal control set no greater goal than to probe a limited relationship between some aspect of speech and a particular behavior, usually fundamental questions about the ontogenesis and nature of the human speech system and its relationship to wider human cognitive capacities are involved. Luria has set his experimental program in verbal control within the framework of the ontogenesis of the speech system, and it is the purpose of this paper to examine his very distinctive approach: his theory, a replication of one of his experiments and a discussion of the difficulties and possibilities growing out of his model. It is beyond the aims set for this article to critically examine the many ways that the concept of the verbal control of behavior is currently understood in the American literature. Suffice it to mention briefly a number of differing uses of the concept without any attempt to analyze their similarities of differences, in order to bring Luria's concept into sharper relief.

Some of the current meanings given to verbal control are: (1) The direction of a person's attention by verbal means to features of a situation which he would not otherwise attend to. (2) A person's control of his own behavior by self-instructions. (3) The use of words or sentences by a speaker to set into motion an implicit behavioral tendency within another person which causes a redirection of his ongoing activity. (4) The use of words as conceptual labels to facilitate the making and remembering of a discrimination between situations or stimuli.

Luria, in contrast to these approaches, is interested in two aspects of the verbal control of behavior: on the one hand as a physiological and cybernetic process, and on the other as one inter-related aspect of an ontogenetically developing, distinctively

human speech system, helping to make possible such higher mental processes as logical thinking and planned behavior. He regards the ability of the individual to prefigure and control his future sequential behavior as one of the most important characteristics of human speech, as the prerequisite for the sine qua non of 'voluntary' behavior. There are undoubtedly areas of overlap between Luria's conception of verbal control and the conceptions listed above, but there is also a distinctive emphasis and thread running through Luria's conception which is different from any one of these approaches.[2]

Luria's conception of the verbal control of behavior is intertwined with a theory of the genesis and role of language in all of its aspects. However, Luria refers to this fact only in passing when he discusses his verbal control experiments, and it will not be possible to do more than that in this discussion. Luria's views of other aspects of language development may be obtained by consulting a number of his publications in English which deal with these questions (Luria, 1959b, 1959c, 1960b, 1966a, 1966b; Luria and Vinogradova, 1959; Luria and Yudovich, 1959). In brief, Luria views language as a distinctive signaling system that humans alone possess which has four functions: a nominative role (direct reference), a generalizing or semantic role (conceptual), a communicative role (syntax, phonology and semantics), and the role of regulating, directing or controlling (planning or programming) sequential behavior (Luria, 1960a, p. 379). Thus, the regulating role is viewed as one of the four fundamental and distinctive functional attributes of the human speech system.

The concept of the verbal control of behavior, Luria holds, can only be grasped by understanding the interaction of two signaling systems -- the non-verbal (first) and the verbal (second). The coexistence and mutual interaction of two signaling systems is a species-specific attribute of humans alone (Luria, 1960a, p. 383). The human individual knows and interacts with the objective environment (physical and social) through these two systems of cognitive mechanisms, but both are usually involved in any cognitive activity.

The system of signals generated by the physical attributes of the environment constitutes the first signaling system. It develops first in ontogenesis and at this stage

provides the child with an integrated representation of the world on a visuo-spatial and motor level.

The verbal system begins to develop when the child is about a year old. Initially it has more of the attributes of the first signaling system than it has of the adult human symbolic language system it will eventually become. Luria points to experimental evidence that the word's significance at this age is far from that of an abstraction or symbol. As a signal of objective reality, it is still intimately related to such non-verbal factors as the action situation in which it is used, the person who utters it, the intonational pattern of the utterance and the fact that its meaning is limited and specific rather than abstractly generalized (Luria, 1960a, p. 380). The second signaling system arises in development out of the first signaling system. From its inception, the verbal system participates in the mediation of new experience along with the first signaling system. As the language system develops it more and more mediates first signal system interactions with the environment. As it continues to develop it becomes semi-autonomous, making possible the development of cognitive abilities far beyond those inherently possible in the first signaling system alone.

How language greatly increases the capacity to learn from experience Luria discusses (1955, pp. 120-123) by contrasting human learning, with the participation of language, with animal learning which is without benefit of a language system. He makes the following points:

(1) For an animal to learn a new association or develop a differentiation, Luria states, the process is gradual, it requires many repetitions, and goes through definable stages. This is especially true in the animal's learning to inhibit inappropriate reactions in the formation of a differentiation. Once an animal achieves a system of connections of appropriate behavior to certain stimuli, these systems remain unstable and are easily disrupted by external factors. In man, because he has a verbal system, many systems of connections can be formed without this difficult process and they can be sustained without the subsequent instability.

(2) The speech system is able to retrieve systems of connections learned previously and bring these to bear on solving a new problem, frequently enabling a solution to be found instaneously.

(3) A system of connections built up in an animal will begin to fade unless constantly reinforced. Verbal connections generally are not subject to this rule.

(4) If a system of connections carefully built up in an animal is altered, it is a difficult process and frequently exhausts the animal. Speech connections, by contrast, are extraordinarily mobile (flexible) and are easily replaced by new ones. It is possible for example, easily to alter the significance of a whole verbal complex of connections by altering only one link, and accomplishing this also 'instantaneously.'

(5) Prolonged training is often required to establish new connections in animals, especially when the distinctive cues required for the learning are not immediately perceptible. The verbal system makes possible learning based not only on not easily perceptible cues, but also based on abstract relationships for which there are no sensory cues.

Luria emphasizes the joint activity of the two systems. New motor connections, i.e. as in motor skill learning, do not always take place initially in direct experience and later become reflected in language, 'handed over' so to speak to the second signal system. In some cases it may happen this way, but it is equally true that new motor connections may be formed initially within the speech system, and through it the new motor sequence of behavior is organized and guided. Luria clearly states his position on the joint functioning of speech and non-speech cognitive systems in learning in this statement: "In a normal child aged from 5 1/2 upwards, and still more in an adult, the formation of new connections takes place with the <u>closest possible participation</u> of the verbal system, that is, it takes place in <u>both signal systems</u> simultaneously" (Luria, 1955, p. 118) [my emphasis].

Behavior that is initiated in the verbal system is regarded by Luria (1966a, p. 234-236) as 'voluntary' behavior. It is initiated and guided by an 'intention,' 'plan,' or 'image,' which includes verbal components and which prefigures the behavioral action as a

whole. In the case of motor behavior, the verbally infused plan acts to program a motor plan which in turn controls the behavior. In order to do this there must be feedback connections, both from the periphery to the functional system embodying the motor plan and from it to the functional system embodying the verbal plan. Mismatches or discrepancies between the plan and its execution can be corrected easily by the verbal system which makes possible the introduction of quick alterations into the motor plan. Luria associates the verbal motor planning function with frontal and prefrontal areas of the brain (Luria, 1966a, p. 234-236).

The monitoring of on-going behavior by a previously set 'intention' or 'purpose' is characteristic of much of Soviet psychological thinking, even when applied to conditional reflex behavior in animals or to sensory image controlled behavior in animals or very young children (Luria, 1966a, p. 234). A full exposition of this point of view will be found in Anokhin (1961, p. 75-103). Luria applies this cybernetic model to human verbally controlled behavior.

One of the utilities that Luria derives from the distinction between a first and second signaling system, both organized according to cybernetic principles, is that he can point to a continuity in cognitive development (with neurophysiological underpinnings) from the lower animals to man, and from early childhood to adulthood (Luria, 1966a, pp. 223-225, 228-231, 234-263). Yet at the same time he is able to point to the verbal system as a new qualitative level of cognition. His model thus meets the criterion that a theory of language should be congruent with a general theory of behavior (Osgood, 1963, p. 751).

The verbal system thus makes possible a new type of behavior: the production of novel behavioral sequences without prior practice and without a period of trial-and-error behavior or multi-trial conditioning. In the area of verbal regulation, this capacity follows from the creative property of language production pointed out by Noam Chomsky, George Miller, J. J. Katz and others. That is, "Fluent speakers both produce and understand sentences that they have never previously encountered, and they can do this for indefinitely many such novel sentences. In the normal use of language, the production and com-

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prehension of new sentences created on the spot, is the rule rather than the exception" (Katz, 1966, p. 100). Thus, in both its communicative and in its regulative aspect, the verbal system makes possible novel and flexible behavior without the tedious conditioning paradigms necessary for animal learning.

Luria believes the ontogenetic development of the regulative speech function involves much more than a simple gradual quantitative growth of vocabulary and syntactic competence. It requires the first six years of the child's life, filled with a series of cognitive transformations, for the child to achieve 'full-valued' language. These in turn are intimately dependent on qualitative maturational and learning changes. Full-valued speech includes using words as concepts, speaking and thinking in the basic types of grammatical sentences of the language, the mastery of all of the phonemic distinctions of the language and their adequate articulation, and the beginnings of using the verbal system to analyze, organize and plan future behavior.

Luria sees a particular role for the command ('request,' suggestion,' or 'instruction') in the ontogenetic development of the verbal regulation of behavior (Luria, 1960a, p. 359). With Vygotsky (1962) he believes the regulatory role starts with the mother's commands to the child. With development, the child begins to interiorize the commands and they then serve as the basis for his control over his own behavior. The mother's use of increasingly complex commands as the child develops is seen by Luria (1960a, p. 359) as an important vehicle for the "interiorization of social conduct, creating new levels of behavior."

Luria's view of the role of the command as a vehicle for teaching the child how to regulate his own behavior parallels the hypothesis of Roger Brown and Ursula Bellugi (1964) of the tutor-pupil relationship between the mother and child for the child's learning of syntax. Brown and Bellugi's recording of the mother's and child's speech in their everyday interactions shows that the child reduces the mother's speech to what he can understand or process, and that she in turn expands the child's 'telegraphic' speech by adding one or two words, just enough to widen the child's use of the speech system. For example,

the mother says: "Fraser will be unhappy," and the child imitates "Fraser unhappy." The child says "There go one" and the mother expands, "Yes, there goes one." In both cases, the words deleted by the child or added by the mother are the functors, i.e., they perform syntactic more than semantic or reference functions.

Before describing Luria's concept of the stages through which verbal regulation of behavior evolves, it should again be noted that, although the focus is on the verbal regulation of behavior, in the particular experiments which he discusses Luria is always aware that this speech function evolves in intimate interaction with the other speech functions. Thus, the stages he delineates are not only stages in the growth of verbal regulation, but stages in the growth of the semantic and syntactic functions of speech as well. Actually, the stages are even more encompassing -- they are stages of cognitive development which are defined by a total system of relationships between the child and his objective world (Luria, 1966c).

In Stage 1 the command instigates direct simple behavior, e.g., behavior that involves a direct single action, requiring neither preliminary analysis nor sequential organization. Stage 3, by contrast, is the one wherein full-valued verbal control is established. Stage 2 then is an intermediate stage which has several sub-stages which represent steps toward full-valued verbal control. The three stages will now be discussed in more detail.

Stage 1 extends chronologically from approximately the age of nine or ten months to 20-24 months. The child is only capable of responding adequately to direct simple commands. If the commands given him are more complex, his response will be to a direct salient element, probably that embodied in the most vivid content words. But not only is the child in the first stage unable to respond adequately to psychologically complex commands, even direct simple commands are subject to three neurologically based constraints:

(1) The ability to respond to a given command may be overridden by the influence of novelty in the environment. Luria attributes this to the fact that the child's strong orienting responses, still unconditional, are not yet under conscious (i.e. verbal) control (Luria 1959a, pp. 351-356).

This is illustrated by putting two toys before the child: a brightly colored cat is placed closer to the child (one of his favorite toys) and a toy fish farther away. The child is given the command to bring the fish to the experimenter. The child of 13 or 14 months orients initially toward the fish as a result of the command, but then reaches out for the cat, and brings it instead to the experimenter.

(2) Commands which change a previously established motor pattern frequently do not control behavior because there is a strong tendency for the previously established motor pattern to perseverate. For example, a child has set before him two toys, a fish and a horse, and is asked to give the fish to the experimenter a number of times, and then asked to give the horse. The child usually gives the experimenter the fish, showing the perseveration of the motor stereotype (Luria, 1959a, p. 351).

(3) The very young child, in certain experimental situations, does not seem to be able to retain a memory trace of the command for more than approximately ten seconds. Thus, if the child is told that "a coin is under the cup...find the coin," and then told "the coin is under the tumbler...find the coin," he is able to perform correctly at about 20-24 months of age. However, if he is asked three times to find the coin under the cup and then is given the instruction "the coin is under the tumbler...find the coin," and his execution of the command is delayed ten seconds, the verbal instruction loses its effectiveness (Luria, 1959a, p. 355), and again the motor stereotype previously learned dominates his behavior, i.e., he looks for the coin under the cup.

Luria draws the following conclusions from these and other similar experiments: (1) The nominative (direct reference) function of speech is more developed than the regulative function at this age. (2) Simple commands easily control behavior in non-conflict situations, but the orienting response takes over when objects are present that are more interesting than those which are the object of the command. (3) Motor learning, when it has preceded a verbal instruction, tends to override the effects of the instruction. (4) The visual image, to which the child's attention is directed verbally may override a motor stereotype toward the end of the first stage. However, if a delay is interposed be-

tween the command and its performance the memory trace fades and renders the command ineffective. Overall, by the end of the first stage, simple verbal commands are able to direct the child's behavior and overcome these constraints. These constraints continue, however, to affect verbal control when the child is given more complex commands until the child has achieved 'full-valued' speech.

Stage 2 is marked by the child's ability to begin to respond adequately to commands of somewhat more complex psychological content. These require for their communication a syntactically more complex sentence than the imperative form of a simple declarative sentence. The verbal directive role is now played "not by a separate word, but by a relation, a synthesis of words entering into a sentence..." (Luria, 1959a, p. 356).

Luria's experimental program centers on the conditional sentence. A simple conditional sentence would be "When I say 'Go' clap your hands." A slightly more complex one would be "Every time I say 'Go' clap your hands." This grammatical form, as compared with the simple direct imperative sentence, requires the imposition of a delay on the immediate execution of the command. It also requires a preliminary analysis by the child, the formation of a program of sequential sub-acts, and a readiness for a flexible rather than a stereotyped running off of the action. Of course, with a little practice, such simple actions quickly become automatized. The child is able to master simple forms of conditional actions in response to a preliminary command during stage 2, but not to more complex commands.

Such an 'easy' conditional command as "When the light flashes, press the bulb" at first does not precisely control the 2 1/2 to 3 year old child's behavior, Luria found. The child usually orients to the separate components of the command and may respond to one or the other. For example, he watches for the light flashes, but doesn't press the bulb, or he presses the bulb before the light flashes and continues to press it after the light stops flashing. He does not make a synthesis of the components of the action to form a pre-established system of connections (a program) which is then able to control his behavior to the conditional signal when it appears.

At approximately the age of 3 to 3 1/2 the child achieves this ability, but this yet is not sufficient for him to carry out the command entirely adequately. Despite his understanding of the command, and his eagerness to execute it, the motor excitation of the pressing often continues during inter-stimulus intervals and the child is not able to inhibit them. The motor activity, once begun, tends to dominate the child's activity rather than the verbal instruction. But by the age of 3 1/2 this verbal instruction usually is able to control this simplest of conditional behaviors.

If, however, the command to the 3 1/2 year old is made slightly more complicated, verbal control is again lost. Thus, if the child is asked to press only to a red light and not to press to a blue light, he is unable to inhibit the tendency to press to the blue (Luria, 1960a, p. 367).

Between the ages of 3 and 4 years (Luria, 1961, p. 611-620) the child's use of his own external speech sometimes helps and sometimes hinders the performance of the conditional excitatory-inhibitory command given above. For example, when the child says "Press," as he presses, he assists his correct responding to the positive signal, but when he says "Don't press" he increases his incorrect responses to the inhibitory signals, i.e. he presses even more. Other experiments show that during Stage 2, the use of external speech, when it helps improve performance on responses to excitatory signals, does not do so because of the semantic content of the command per se, but because of the motor impulsive side of speaking the word "Press."

Stage 3 is marked by the child's ability to use external speech to stabilize responses both to excitatory and inhibitory signals in the conditional excitatory-inhibitory command, and the child is able to use his verbal system to bring his diffuse motor impulsiveness under control. This, together with the other aspects of verbal control, becomes established between the ages of 4 and 6 years (Luria, 1960a, p. 382).

In Luria's experimental program a fundamental distinction is made between 'simple' (non-conditional) and 'complex' (conditional) commands. The non-conditional commands have no hidden components, whereas there are implied or hidden inhibitory components in

the simplest conditional commands. For example, the command "Throw the ball" may be executed immediately and directly (assuming a ball to be present) without preliminary analysis of what is required for the action sequence. However, the command "Every time the light comes on, press the lever" has three hidden components, namely, (1) Don't press until the light actually comes on, (2) Don't press between presentations of the light, and (3) Don't press after the last presentation of the light. This may all seem self evident, but most 3 year old children do not in fact recognize these components hidden in the psychological content of the command, or, in any event, this is Luria's contention. The conditional command may, in turn, be made more complex by increasing the number of components which must be sequenced in the behavior by including additional explicit inhibitory components and discriminations. These experiments do not at all exclude other dimensions of complexity. Evidently Luria believes that conditional behavior, which requires the ability to inhibit a direct 'automatic' response to a stimulus, is one of the most important features of behavior which the verbal system is able to efficiently control, once it has developed sufficiently.

Luria characterizes the child's six year speech development by noting that it culminates in a new level, which provides a basis for new cognitive capabilities to emerge. As Sheldon White (1965, p. 208-209) observes, Luria's observation that there is this turning point in the speech function in fact coincides with other observations of a turning point in a number of the child's cognitive capabilities at this same age. White presents an array of evidence of a broad spectrum of change between the ages of 5 and 7 based on the developmental studies of cognitive processes by many psychologists. Luria's work, showing the maturation of the child's ability to control his own behavior through his verbal system between 4 and 7 years of age would suggest that the acquisition of this capacity may interact with other cognitive changes to play a decisive role in all of the changes characteristic of the end of the pre-school period in the child's development.

One of Luria's contributions, I believe, is his thesis that the child's speech development in the early years is working toward a level of integration which, when reached

(around age 6), can be described as having all the unique characteristics of human speech. Luria's approach, in this respect, differs from certain other well known approaches as follows:

(1) It views human speech as being formed in ontogenetic development, rather than subscribing to the traditional view that it merely grows. The formation of human 'full-valued' speech involves a series of transformations (characterized as sub-stages) rather than simply quantitative increases in vocabulary, grammatical rules, S-R connections, sentence length, and the like.

(2) It differs from the notion of "verbal mediation." The proponents of this idea talk about an age break at about 5-6 years, above which the child uses words to mediate perceptual discriminations and below which there is a "verbal mediation deficiency," i.e. the child may have the words required for mediation, but doesn't use them. Luria's view is that there is a succession of sub-stages which lead to 'full-valued' speech, which is propositional syntactically organized speech rather than speech limited to the role of words as 'mediators.' 'Full-valued' speech includes as one of its characteristics the ability of speech to conceptually mediate first signal system experience. Luria would say that from the beginning, e.g. even at age 2, the child uses speech to mediate experience and behavior in a number of different ways, although on a lower level than at age 5-6, i.e. verbal mediation has different structures both within and between age levels. Nor does Luria view conceptual verbal mediation after the age of 6 as completely formed. Rather, there then follows a new major stage in its elaboration and growth, again with many sub-stages, each involving a restructuring of the psychological processes involved.

(3) It views the development of the speech system in a holistic way, i.e., as an extremely complex inter-action between speech and non-speech cognitive processes, as dependent on differential maturation rates of brain areas subserving differing functional systems of perception and behavior, and as intimately related to and determined by the social milieu. This is a much different emphasis that is found in that trend in American psycholinguistics which interprets language acquisition almost exclusively as the growth of an autonomous and innately unfolding grammatical competence.

The author found interesting Luria's claim that it is possible to show the process toward full verbal control which takes place in the transitional sub-stage which leads directly to the achievement of a full-valued speech system. For this reason he decided to replicate (out of the many experiments which Luria describes) one of those which uses a preliminary complex verbal command to organize and guide a sequence of the child's motor behavior, behavior that includes conditional, excitatory, inhibitory and discriminative components. I have called it Luria's paradigm experiment because, to the extent that a single experiment can, it epitomizes Luria's theortical claims.

Luria describes this command informally as one in which the child is told to "press a bulb in response to a red signal and not press in response to a green signal" (Luria, 1960a, p. 609). He found that it becomes operative in instigating corresponding behavior between the ages of 4 and 6. Luria's references to the experiment in the articles available in English lacked details as to experimental design, parameters of variables and statistical treatment of data. These problems were approached as nearly as possible in the spirit of Luria's approach as evidenced by his descriptions and argumentation in the previously cited articles. Only those changes were made which might 'tighten up' the experimental design but not change it. The gain to be derived from this procedure was to find whether, under the same experimental conditions, it was possible to come out with the same kind of data as Luria found. If this proved to be the case, there would be a common starting point from which to probe more deeply into the implications of Luria's overall hypothesis of the development of the regulatory function of language. The following account focuses on two of the experimental conditions which are pertinent to this situation.

Methods and Procedures

Subjects

Thirty-two Ss between the ages of 41 and 78 months were used from the Perry Nursery School for working mothers in Ann Arbor. There were 19 boys and 13 girls, 10 Negro and 22 white Ss, all apparently of normal intelligence (no psychometric data was available).

Apparatus

The experiment was conducted in a mobile laboratory which was parked next to the nursery school during the experimentation period. The combined stimulus display and response unit had a clown's face painted on it. A red light was the clown's left eye and a green light his right eye. A spring loaded lever which could be depressed six inches was in the nose position; a small speaker covered by a screen was the mouth. The lever was internally connected to a potentiometer which in turn was shunted across the input terminals of a Bausch-Lomb chart recorder. Depressing the lever actuated the recorder pen so that the amplitude of the response (proportion of performed lever depression compared to total possible depression) was recorded on moving chart paper.

The child faced the clown face unit sitting in a chair at a low table. E sat at the child's right some distance away at the end of the long table. The child could not look at the stimulus light flash and the experimenter at the same time. A cable ran from the apparatus to E, terminating in a control box with buttons for actuating the signal stimuli. A pulse from the signal stimulus automatically fed into an event marker circuit of the recorder so that the beginning, duration and ending of all stimuli and the same for responses were displayed on the same moving chart.

Procedure

Ss were run between 3:00 and 4:00, immediately following the children's afternoon nap and milk and crackers. The experimental tasks were presented as a game with a strange kind of clown face that could blink its eyes and make a beep sound.

The child was seated in front of the apparatus and told by E to "listen carefully to what I say, and do exactly what I tell you." E read the instructions for each of the tests (given below), insuring uniformity of presentation of the instructions to all Ss. Each child was given a preliminary five trials of the direct command "Press the lever down and let it up one time" to familiarize him with the correct form of the response measure.

Two stimuli were used for the tests described in this paper: a red light and a green light. The length of stimulus presentation varied randomly from 3/4 second to 1 1/2 seconds. Inter-stimulus intervals ranged between 1 and 3 seconds, randomly varied. The decision to make the stimulus time parameters variable was to prevent habituation to a repetitive, monotonous series of stimuli (Magoun, 1963, pp. 106).

When a child asked E a question relative to the experiment, the reply was: "Do just as I told you," or "Keep looking at the clown's eyes," and proceed to the end of that block of signals.

The instructions for the two tests were:

Test 1. "When the red light flashes, don't push down. When the green light flashes, push down." There was a total of 20 presentations in two blocks of 10 each with a 5 second pause between. The command was repeated before the second block of 10. All Ss were given the same random sequence, which was R-G-R-R-G-R- G-G-G-R. Green was positive and red negative in this test, the replication of the Luria paradigm experiment.

Test 2. "Listen carefully. This time, when the red light flashes, push down, but when the green light flashes, don't push down." There were 10 stimuli presented, with red positive and green negative, thus reversing the attributed significance of the two stimuli, compared with Test 1. However, the random sequence of red and green light flashes was the same, but with opposite sign. Test 2 was used as an approximate verbal command analogue of a non-verbal "discrimination reversal."

The command in each case was given once. If the child requested a repetition before the stimulus presentations began, it was repeated for him.

Scoring

A response was considered to be made whenever the lever was depressed 25 percent or more of its total travel. Responses of less than this magnitude (and such responses actually were given only to negative stimuli) were not recorded as errors but as "aborted" responses, i.e., were counted as correct.

In the paradigm condition (Test 1) the only response scored correct to a positive signal was one which started after the stimulus began and terminated before the onset of

of the next stimulus. If more than one response occurred between stimuli, or a response overlapped the stimulus presentations, the response was scored as incorrect. Any lever depression (over 25 percent) between the onset of the negative stimulus and the onset of the next stimulus caused the response to be scored as "incorrect." The onset and offset of stimuli and lever presses were clearly displayed on the chart paper and there was no scoring problem. Latencies were calculated for all correct responses to positive stimuli as the difference between the beginning of the stimulus and the beginning of the lever depression.

Results

The results showed that there was an increasing ability with age to perform the differentiated behavioral sequence in response to a single preliminary verbal command. The paradigm test (Test 1) showed an increase from 59 percent correct responses at the age 3 1/2 - 4 1/2 to 96 percent correct responses at age 5 1/2 - 6 1/2 (significant, $p < .02$). The results also showed that once verbal control existed it was as easy for the child to respond immediately and without practice to stimuli whose significance had been reversed as it was to respond to the stimuli in their original imputed signification (Figure 1). This was further borne out by the fact that response latencies on the two tests showed no significant differences. This finding supports Luria's claim of the greater mobility (flexibility) of verbal over non-verbal learning (point 4, P. 5).

Insert Figure 1 about here

Discussion

This experiment apparently generated data similar to Luria's. The ability of a sentence of the defined complexity of the one used in the experiment to control adequately the child's ensuing behavior begins around the age of four and is achieved by all Ss at around age six.

Do these data, however, provide evidence for some of the more detailed claims which Luria derives from his hypotheses as to the nature and development of the verbal control of behavior? This is a more difficult question, and many questions remain open on the basis of this and other experiments which Luria describes. Two of Luria's claims are the following:

(1) Between the ages of three and four the verbal system and motor systems tend to conflict whenever the attempt is made to use the former to control the latter in any complex way. From this period until around the age of six the resolution of the conflict is underlain by a maturational process as a result of which a higher level of speech integration is formed. From this higher speech level there are established executive and feedback connections with the motor planning system, thus making it possible for the verbal system to bring sequential motor behavior under its control. To buttress the point that there is an age when verbal and motor systems are insufficiently differentiated (resulting in conflict) Luria says that the child may <u>understand</u> the meaning of the command and yet his verbal system will not be <u>able</u> to direct its performance (Luria, 1960a, pp. 367). To accept this contention of a hiatus between comprehension and motor performance requires in the first place that we can be sure that the child does in fact grasp the whole meaning of a command. The evidence that Luria provides is that the child [all of them?] says to the experimenter "If I see the green I shall not press" (1960a, pp. 367), yet he presses. There are many situations when it is clear to the experimenter, from observing the sureness and consistency of the child's action that his performance in itself constitutes sufficient evidence that the child understands the command's meaning. When performance breaks down it is more difficult to be sure whether or not the breakdown is due to a lack of comprehension or some other cause. In both cases it would be preferable to be able to operationalize 'comprehension' if the experimental procedure itself doesn't do it. In linguistic research it has been difficult to demonstrate unequivocally the distinction between the child's comprehension and production of sentences (where motor behavior is not involved). Fraser, Bellugi and Brown (1963) tackled this problem by operationalizing the distinction experimentally, and some such approach as this would be useful in the present context.

(2) Luria (1960a, pp. 379) asserts that as soon as the child formulates the rule for the motor behavioral sequence to follow in his own exterior speech the basis exists for its interiorization, and between the ages of four and six, the average child does in fact interiorize such commands. He believes that interiorization initially takes the form of an explicit self-command at each critical juncture of the behavioral sequence. The children who are able to perform the behavioral sequence correctly in silence are now assumed to have interiorized the command, and are giving themselves self-instructions in whispered or sub-vocal speech. Somewhat older children may be using "inner speech," which Luria, with Vygotsky (1962, pp. 139) views as an abbreviated from of interiorized speech, i.e. speech reduced to its predicate. It is also possible that after one or two interiorized self-commands the behavior itself quickly becomes automatized and is henceforth able to run off directly as visuo-spatial behavior with no need for verbal mediation on each trial.

Luria offers evidence, some anecdotal and some experimental, that at the age just before verbal control (to positive and negative signals, etc.) is effective, external verbalization does in fact help to regulate the behavior (Luria, 1961, P. 620). As to what happens when the child no longer uses external speech, the design of the present experiment does not make it possible to distinguish between the aforementioned or other possibilities. Luria refers to a conference of Soviet psychologists on the subject of electromyographic recording of speech muscle potentials during various stages of the interiorization of speech (Luria, 1960a, pp. 380)[3] as evidence for his inferences about interiorization.

Jarvis (1968) tried experimentally to operationalize in external behavior one aspect of this problem. In a study using the positive and negative signal paradigm (similar to the author's), he used three conditions: external speech with the positive signal ("Say 'Push'"), external speech with the negative signal ("Say 'Don't push'") and no external speech for either stimulus. The experiment was designed to test the contention made by Luria (1960a, pp. 374) that for three to four year olds the use of external speech degraded performance on the inhibitory task. Jarvis' Ss were given all three conditions, and he found no significant differences in performance in any of his age groups among the different conditions.

His negative finding may be due to differences in experimental procedure from that followed by Luria, and the age range of his Ss. Jarvis gave his Ss relatively extensive training before testing them in the several conditions (whereas Luria stresses the effect of a preliminary command without practice), and all of Jarvis' Ss were within the age range within which Luria would predict they could use speech to control the behavior embodied in the command, the youngest group being on the borderline. (Jarvis' youngest group has a mean age of 47 months and the oldest group a mean age of 81 months.) One might have expected that in the case of the youngest group there would be differences between the conditions were it not for the amount of practice given each S before testing. And, of course the experimenter's instruction to respond "in silence" or "by not saying anything" in the no-speech condition does not preclude the possibility that Ss did in fact use interiorized self-commands.

Luria's approach to the verbal control of behavior is interesting because it suggests many new avenues of experimental investigation. Working within the framework of Luria's model of the verbal regulation of behavior has suggested two areas of further experimental investigation to the author: (1) There should be the beginnings of an attempt to piece together from every possible point of view (neurophysiological, linguistic, external behavioral, etc.) a process flow diagram of parallel and serial processes which will relate motor behavior to linguistic input. This of course involves nothing less than to undertake the task of explaining and empirically verifying the extremely complex nature of verbal mediation in its differing forms. (2) A somewhat easier program which, however, could be formulated in a way which would contribute to the foregoing task, is one of identifying and rank ordering elementary cognitive processes and finding whether and how their complexity (including the kind of complexity) determines their appearance in ontogenesis. This in turn requires an analysis of the criterial components involved in the concept 'the psychological complexity of commands.' The latter is both a logical and an empirical question. It has been suggested that the child of three to four years is able to decode commands because he has interiorized to some degree the syntactic base structure of the lan-

guage in some form of representation of its deep structure (McNeill, 1966, pp. 15). This hypothesized process itself requires demonstration. Assuming that this is possible it would not, by itself, solve the problem posed here. It may be that the psychological complexity of a command for the child involves more than verbal decoding and therefore is not strictly isomorphic with the command's grammatical complexity, i.e., as exemplified in a transformational grammar. An experiment is presently under way by the author designed to investigate some aspects of the psychological complexity of verbal commands and the order in which commands of defined complexity are capable of performance in early development.

The author will not presume at this point to evaluate Luria's contributions to an understanding of various aspects of the acquisition and functions of human language. It is possible to make a few broad generalizations. Luria places the role of language in guiding or controlling human behavior in the context of an integrated point of view which includes all of the fundamental aspects of the human language system, of its unique characteristics and its development. He is one of the pioneers in 20th Century psychology of the idea that an adequate theory of <u>human</u> behavior must incorporate within its broader outlines a definitive consideration of the role of language. At the same time, his hypotheses about the verbal regulation of behavior sets the speech system into a causal relationship with non-linguistic cognitive processes. Luria emphasizes that speech, as a cognitive system, always works in close mutual relationship with non-verbal cognitive processes. The interaction works both ways. The speech system affects perceptual, motivational and mnestic processes, and their development in turn influences the potential of language for mediating, i.e. organizing, guiding and planning future behavior, including the development of 'higher' intellectual operations. His approach thus makes intellectual contact with much current American experimental work in psycholinguistics, cognitive theory and psychophysiology.

Footnotes

[1]I wish to thank Dr. David Birch, Dr. Martin Hoffman and Peter Wolff for their many suggestions and criticisms. I also wish to thank Mrs. Elizabeth McHale, the director of the Perry Nursery School and her staff of teachers for their cooperation.

[2]Miller, Galanter and Pribram in Plans and the structure of behavior, (New York: Holt, 1960, pp. 157) also contend that the speech system makes possible that "a motor Plan could be constructed very quickly and efficiently, not by rote, but by the operation of a higher-level Plan that had the motor Plan as its object." This capacity of the speech system is contrasted with the ability, present in both men and animals, to also construct motor plans instinctively or by long periods of practice.

[3]A discussion based on some of the material of this conference is to be found in the article "Studies on the Problem of the Speech Mechanisms of Thinking" by A. N. Sokolov (in Anan'yev, B. G., (Ed.) Psychological science in the USSR, Vol. I. Moscow: House Acad. Pedag. Sci., RSFSR, 1960), published in English by the Office of Technical Services (Washington, D. C., Office Technical Services, 1961, pp. 669-703). The quality of the translation makes it difficult to get the full import of the discussion however.

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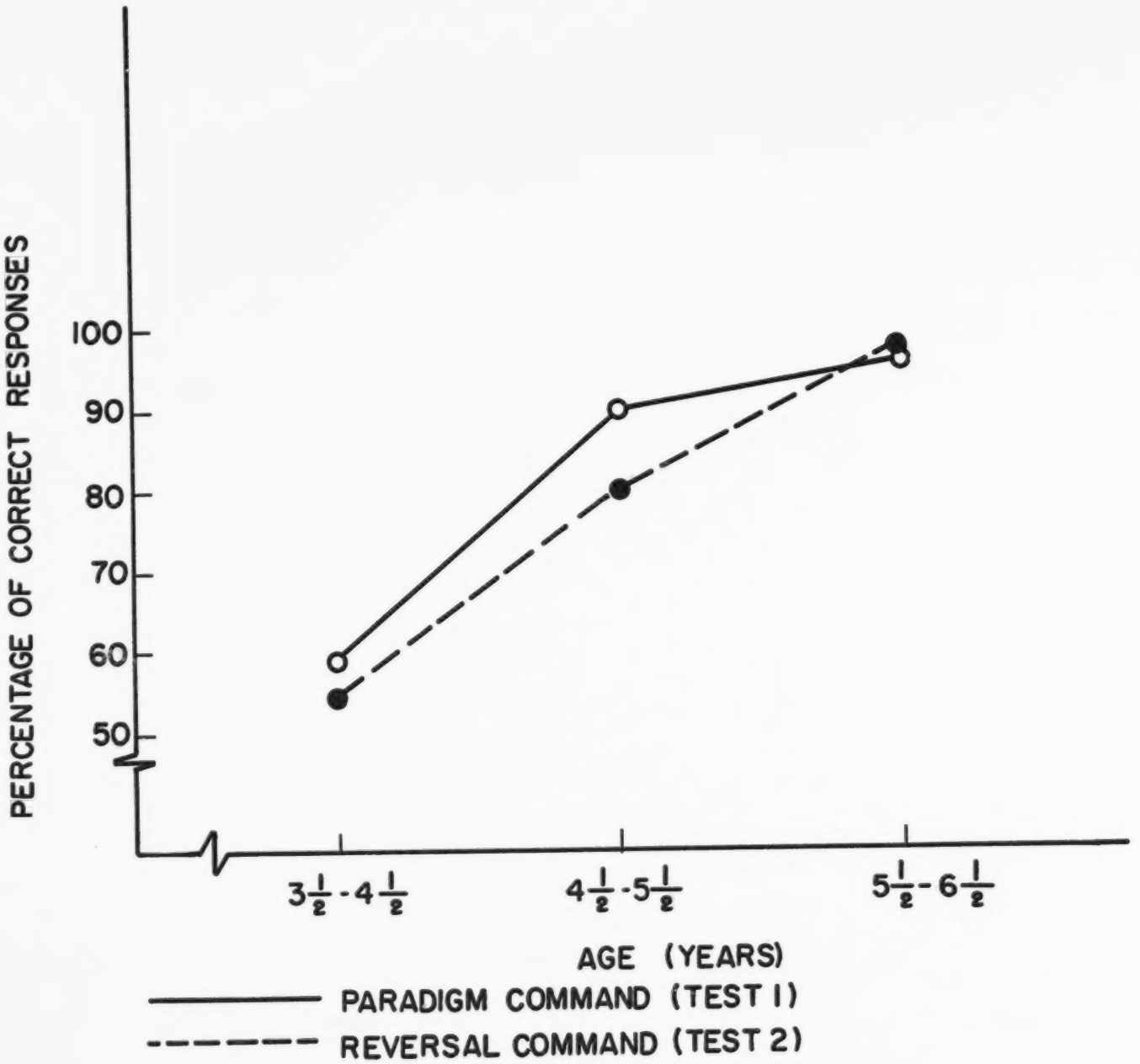

Figure 1

Comparison of Performance on Paradigm Command and Reversal Command